

SDIO Long Wavelength Infrared Detector Requirements

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The Strategic Defense Initiative Organization has a significant requirement for infrared sensors for surveillance, tracking and discrimination of objects in space. Projected SDIO needs cover the range from short wavelengths out to 30 μm . Large arrays are required, and producibility and cost are major factors. The SDIO is pursuing several approaches including innovative concepts based on semiconductors and superconductors.



SDIO INFRARED TECHNOLOGY EFFORTS

**LT COL HILMER SWENSON
SENSORS AND INTERCEPTORS DIRECTORATE**

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AGENDA (U)

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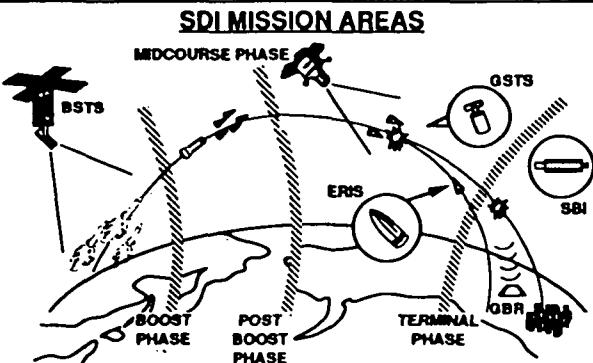
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- SCOPE OF SDIO IR SENSOR TECHNOLOGY DEVELOPMENT
- TECHNOLOGY THRUSTS
 - OPTICS TECHNOLOGY
 - FOCAL PLANE TECHNOLOGY
 - CRYO COOLERS
 - SIGNAL PROCESSORS
 - INTEGRATED SENSORS
- SUMMARY



SCOPE OF SDIO IR SENSOR TECHNOLOGY (U) (U)

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PROJECT 5 MISSION

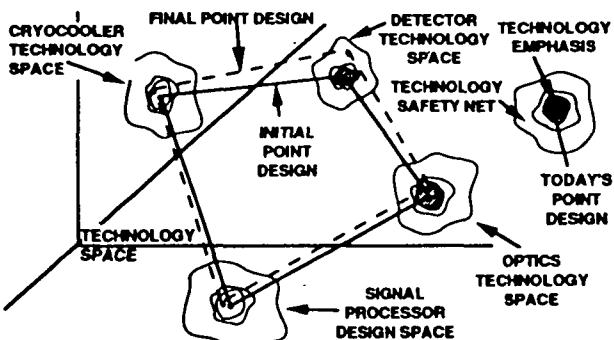
- DEVELOP IR TECHNOLOGY NECESSARY TO SUPPORT SDI SURVEILLANCE AND WEAPON SYSTEM SENSORS FOR PHASE I
- ADVANCE THE STATE OF ART FOR IR SENSORS

AGENTS

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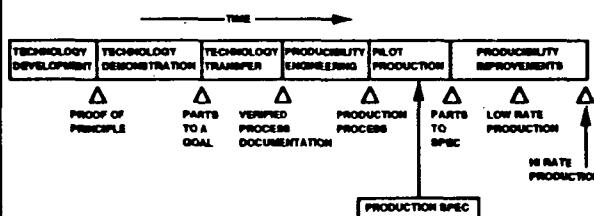
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PROJECT PHILOSOPHY



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TECHNOLOGY MATURITY



CRYOCOOLERS (U)

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DRIVERS

- HIGH RELIABILITY
- EXTEND ON-ORBIT LIFETIME
- HIGH EFFICIENCY
- LOW WEIGHT
- ACCUMULATE OPERATING HISTORY
- REDUCE COST

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CURRENT APPROACH

- TURBO-BRAYTON(3-STAGE)
- ROTARY RECIPROCATING REFRIGERATOR (R -3 STAGE)
- 2-STAGE LIFE TESTING
- DEVELOP THERMAL INTEGRATION TECHNOLOGIES (HEAT PIPE, THERMAL SWITCH)

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NEW TECHNOLOGY

- MAGNETIC COOLING
- SORPTION COMPRESSION
- MIXED GAS QUICK COOLDOWN J-T
- PULSE TUBES
- ACOUSTIC DRIVERS

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NEEDS

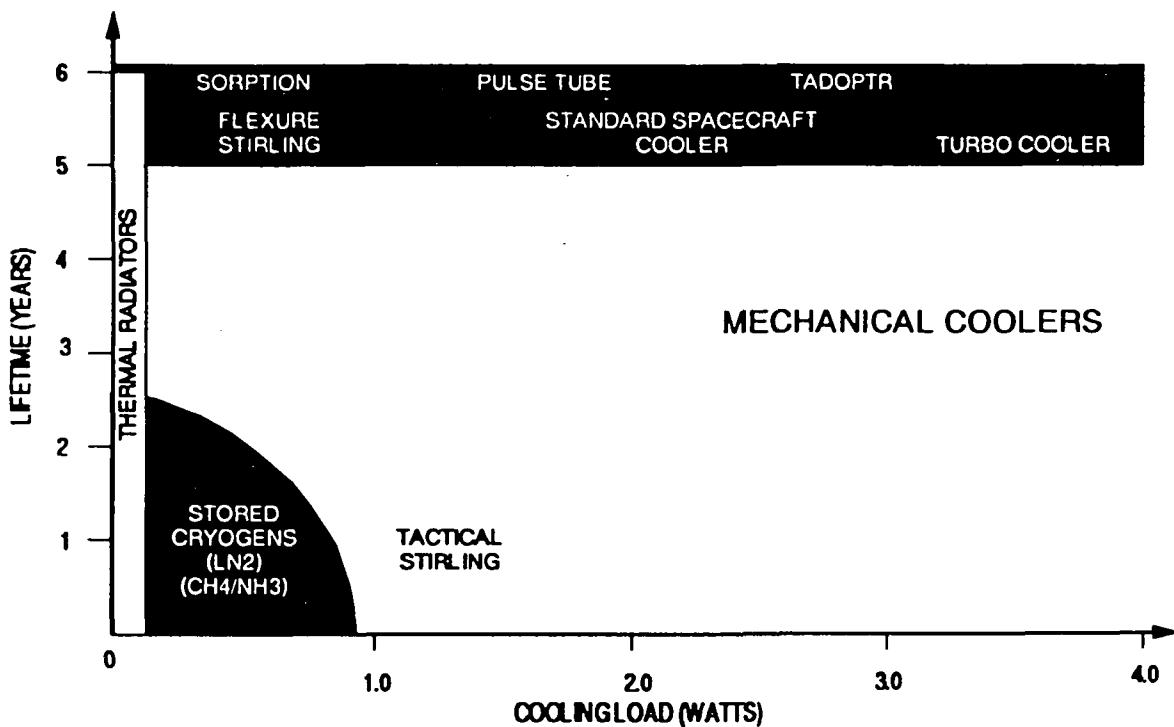
- HARDENED FLIGHT CONTROL ELECTRONICS
- REDUCED WEIGHT HIGH EFFECTIVENESS HEAT EXCHANGERS
- MODULAR/SCALEABLE CRYOCOOLERS
- SOLID STATE CONCEPTS

CRYOGENIC TECHNOLOGY PARAMETERS



ASSUME COOLING TEMPERATURE 65-80K

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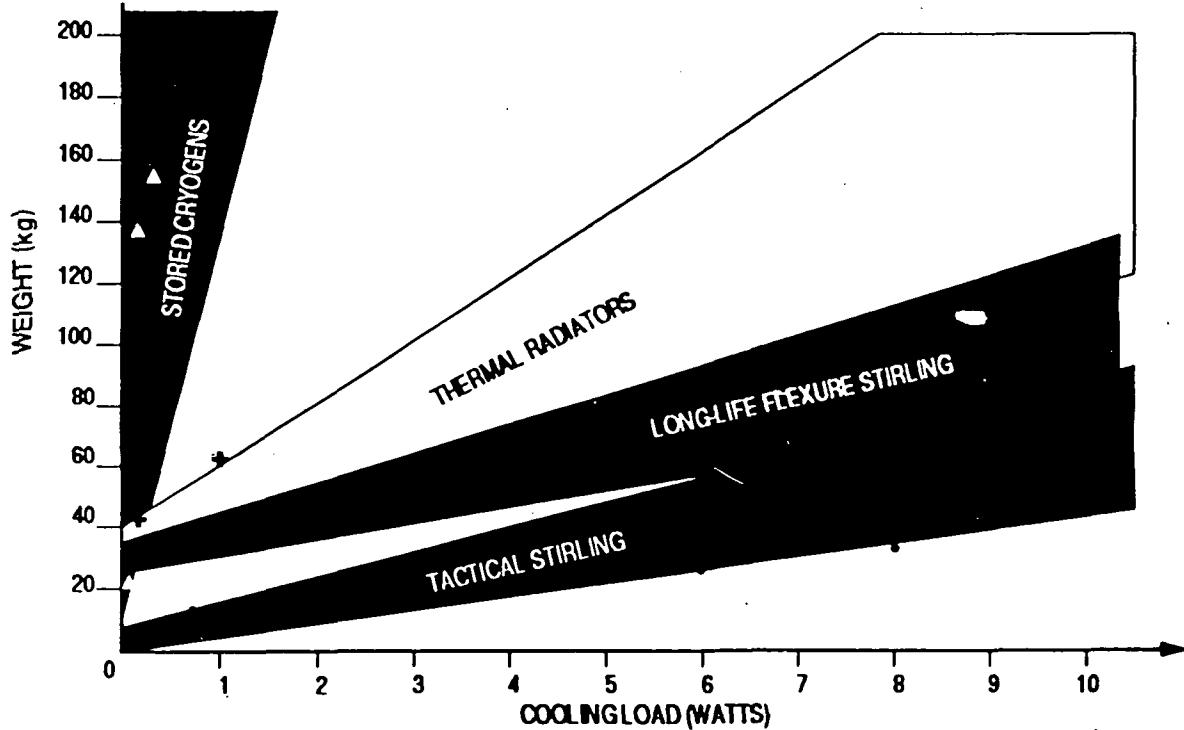


CRYOGENIC SYSTEM WEIGHT



TEMPERATURE 65-80K

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FOCAL PLANE ARRAY TECHNOLOGY (U)

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DRIVERS	DRIVING SYSTEM	CURRENT APPROACH
• YIELD/COST/ PRODUCIBILITY	KEW,GSTS	• MANTECH – MWIR PILOT LINE DEMO FOR BOOST PHASE APPLICATION
• RADIATION HARDNESS	KEW, SSTS	• HYWAYS – IBC HYBRID DEVELOPMENT FOR SSTS, GSTS
• OPERATING TEMPERATURE	SSTS	– ADVANCED HYBRID DEVELOPMENT
• HYBRID PERFORMANCE	SPIRIT III, SSTS, GSTS	– PILOT LINE DEMO
• D*	SSTS, GSTS	• SLIM – LWIR HgCdTe FOR KEW & SSTS BACKUP
• CUTOFF WAVELENGTH	SSTS, GSTS	• HARDENED INSB TECHNOLOGY FOR SCANNERS
• UNIFORMITY	SPIRIT III, GSTS,	
• CROSSTALK	SPIRIT III, SSTS, GSTS	

NEW TECHNOLOGY	NEEDS
• INTRINSIC EVENT DISCRIMINATOR • SOLID STATE PHOTOMULTIPLIER • Ge CTIA • GaAs MUX FOR HgCdTe • HIGH OPERATING TEMPERATURE DETECTORS • HIGH TEMPERATURE SUPERCONDUCTORS • STRAINED LAYER SUPERLATTICE • VLWIR HgCdTe – HIT DETECTORS, SOFRADIR • LWIR Hg CdTe TECHNOLOGY • HgCdTe PASSIVATION TECHNOLOGY	• MODULES • NOISE MODELS FOR HYBRID INTEGRATION • LARGER SUBSTRATES • AUTOMATED TESTING FACILITY • TRAINING FOR TEST FACILITY PERSONNEL • INTEGRATED FOCAL PLANE TECHNOLOGY



IRFPA DESIGN DRIVERS (U)

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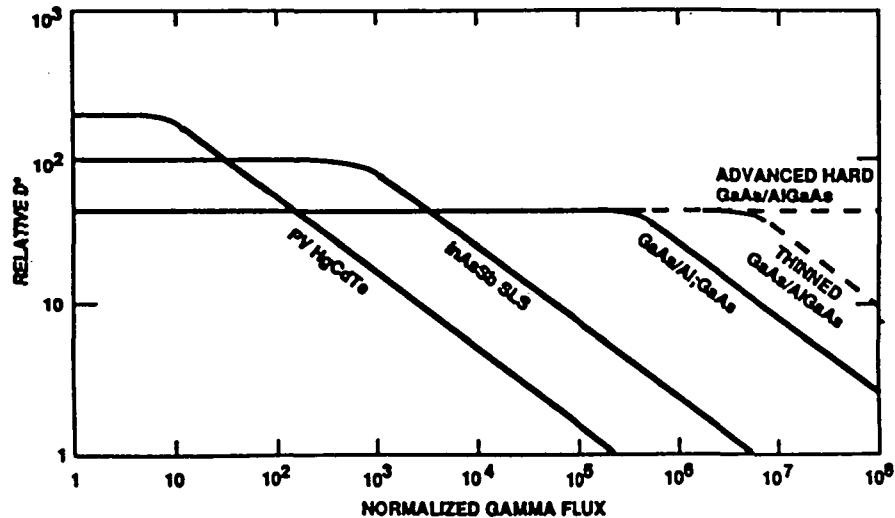
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- LOW TEMPERATURE TARGETS
- LOW BACKGROUNDS
- HIGH TOTAL DOSE ENVIRONMENT
- 3 COLORS REQUIRED FOR DISCRIMINATION
- LARGE FOV – HIGH SCAN RATES
 - SHORT INTEGRATION TIMES
 - HIGH DATA RATES FOR ANALOG SIGNAL PROCESSOR
- LARGE NUMBERS OF TARGETS/DECOYS
- HIGH THROUGHPUT REQUIREMENTS FOR OBJECT DEPENDENT PROCESSORS



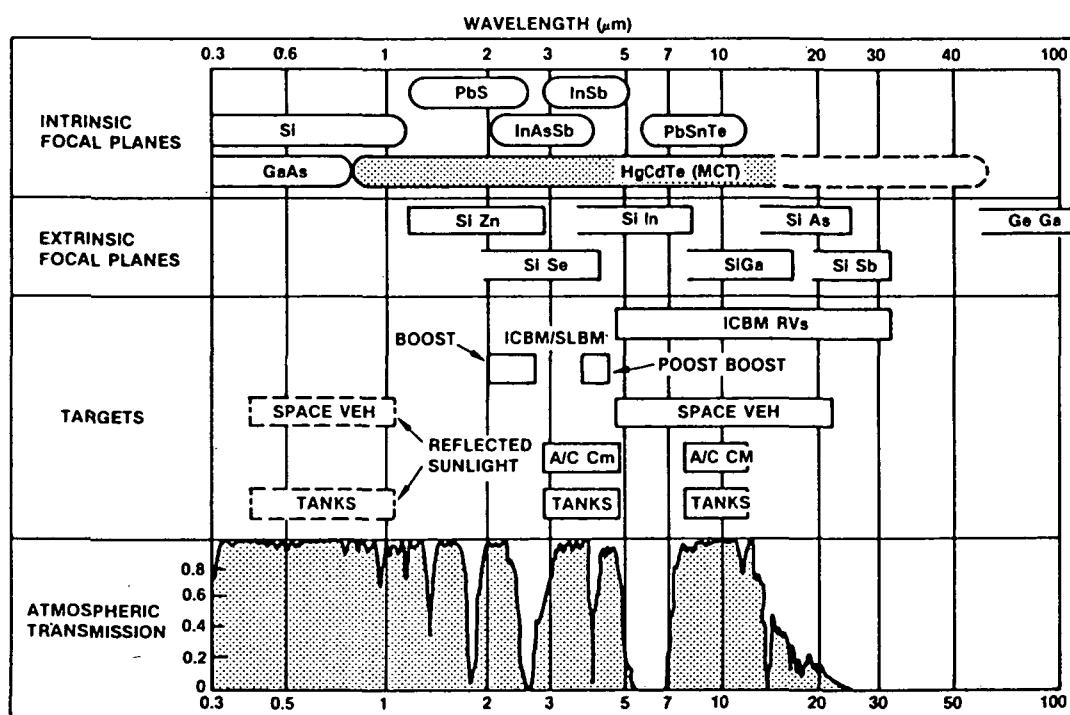
RELATIVE HARDNESS

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MATERIALS/APPLICATIONS MATCH-UPS (U)

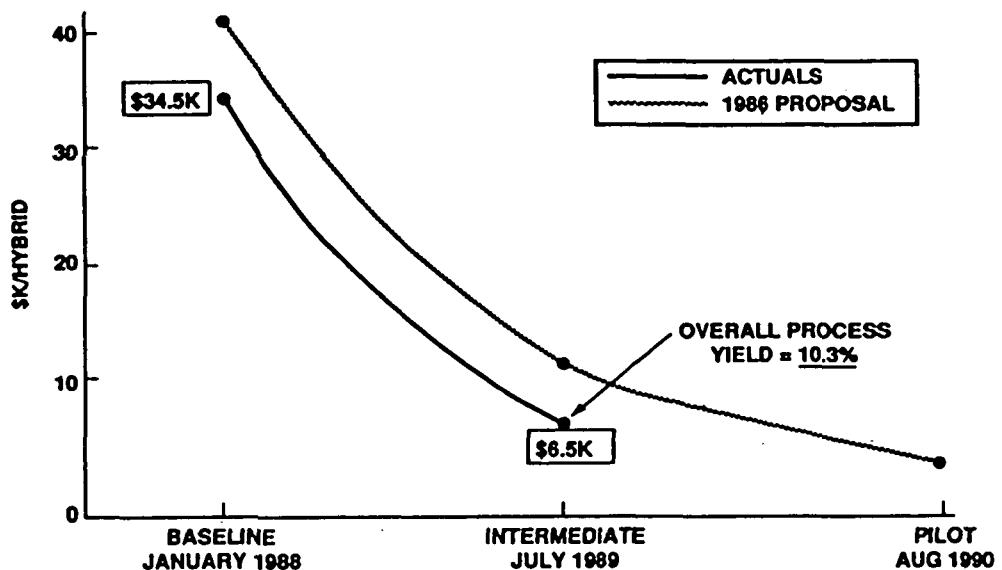
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80% COST REDUCTION DEMONSTRATED WITH INTERMEDIATE RUN



MANTECH STATUS (U)

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ORIGINAL	CONFIGURATION	YIELD	YIELD GOAL	COST/HYBRID	COST GOAL
— ROCKWELL (HYBRIDS)	32x8	0.2	—	\$100 K	—
— SBRC (DETECTOR ARRAYS)	32x8	0.2	—	\$200 K	—
BASELINE RESULTS					
— ROCKWELL (HYBRIDS)	32x64	1.35%	0.4%	\$34 K (100% TEST)	\$20/CHANNEL
— SBRC (DETECTOR ARRAYS)	128x128	3.5%	0.4%	\$15 K (SAMPLE TEST)	\$20/CHANNEL
INTERMEDIATE RESULTS					
— ROCKWELL • YIELD 2X BASELINE	32x64	10.3%	1.5%	\$6.5 K	\$5/CHANNEL (\$3.18 ACHIEVED)
— SBRC • YIELD/PERFORMANCE IMPROVEMENTS • CdTe PASSIVATION	128x128	35% PRO- JECTED	1.5%	\$4.6 K (SAMPLE TEST)	\$5/CHANNEL (\$0.28 PROJECTED WITH SAMPLE TESTING)

OF PIXELS WORKING MADE UNDER MANTECH = >3M

OF PIXELS REQUIRED BY END OF CONTRACT = ~2M

ISSUES REMAINING AFTER MWIR HgCdTe MANTECH (U)

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<u>ISSUE</u>	<u>NEED TO BE ADDRESSED BY</u>
• HARDNESS	TECHNOLOGY PROGRAM MANTECH REVISITED
• PRODUCIBILITY OF NUCLEAR HARD ARRAYS	
• INTERGRATION OF ARRAYS	TECHNOLOGY OR PRIMES
• UNIFORMITY	TECHNOLOGY DEVELOPMENT
• SUSTAINING MARKET PLACE	TATICAL?
• TRUE HANDOFF TO PRODUCTION WITH LESS TOUCH LABOR	DPESO/DSTAR
• THIRST FOR HIGHER PERFORMANCE AT LOWER COST	TECHNOLOGY MATERIALS/ DSTAR LABOR
• RADIOMETRY PERFORMANCE	TECHNOLOGY
• READOUTS	TECHNOLOGY



BENEFITS OF IBC DETECTORS (U)

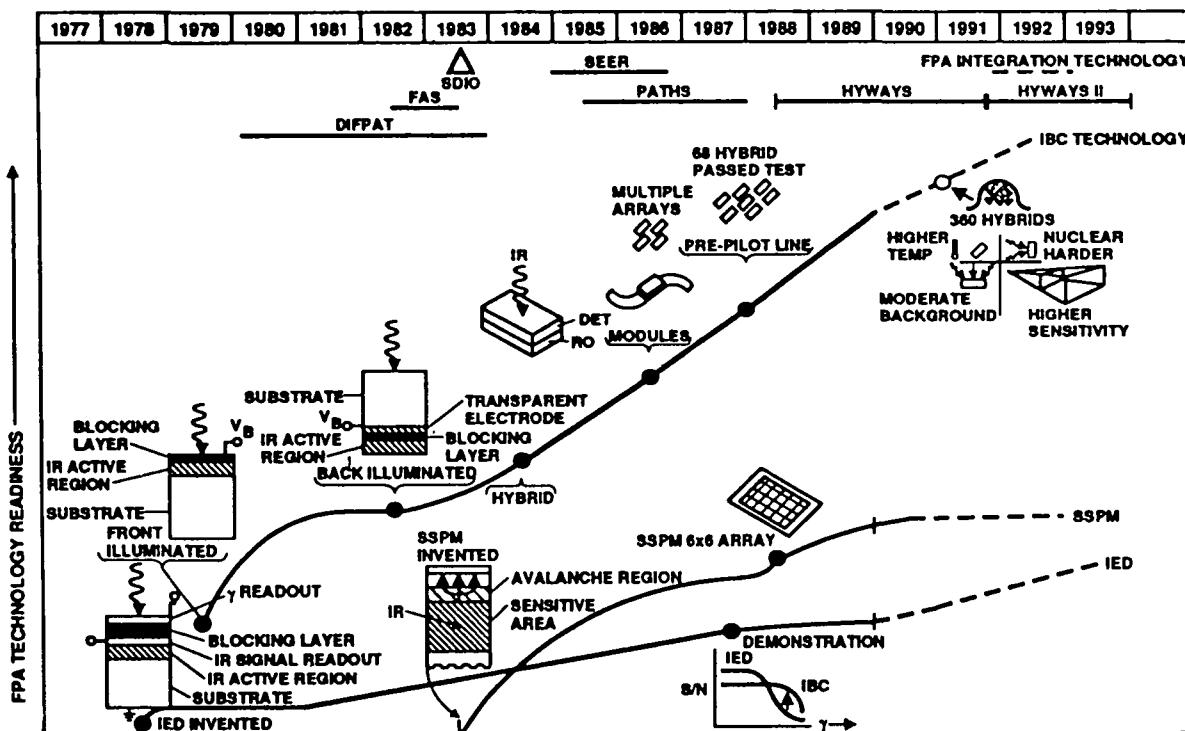
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- RADIATION HARDNESS
- RESPONSE LINEARITY
- FREQUENCY OF RESPONSE
- UNIFORMITY OF RESPONSE
- PREDICTABLE BEHAVIOR
- HIGH RESPONSIVITY
- RELATIVELY HIGH PIXEL YIELD



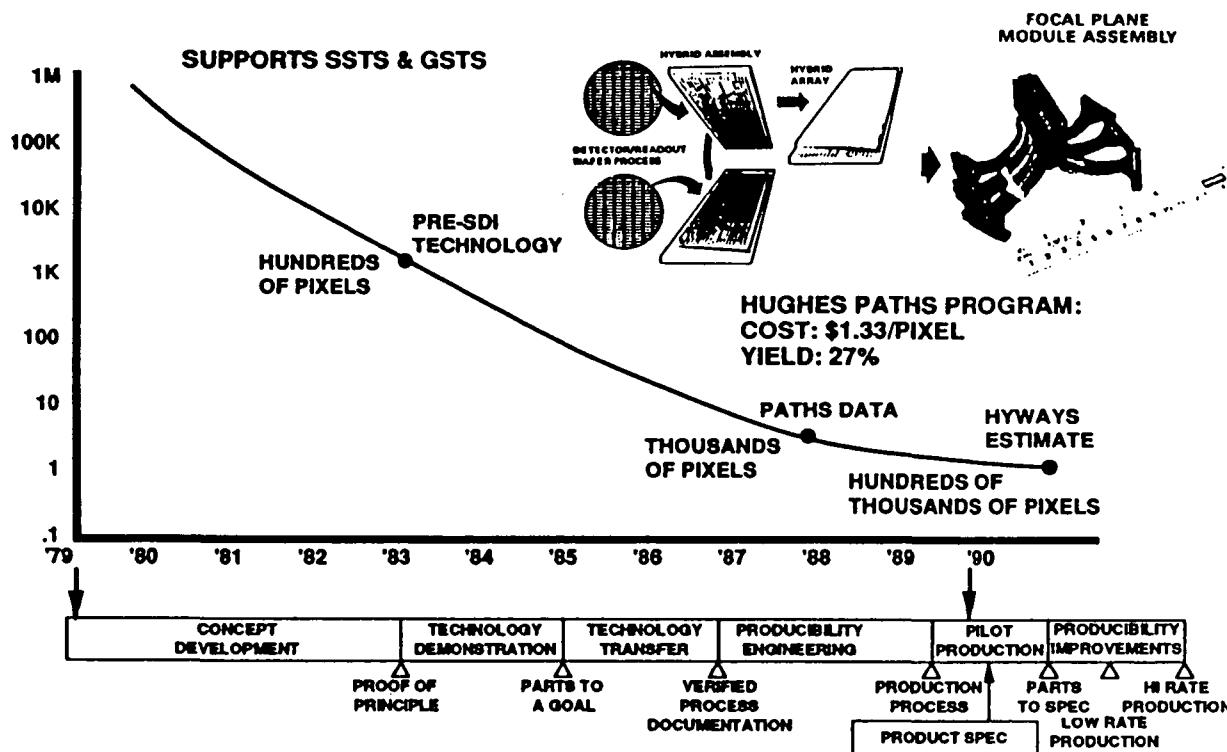
IBC FOCAL PLANE DEVELOPMENT (U)

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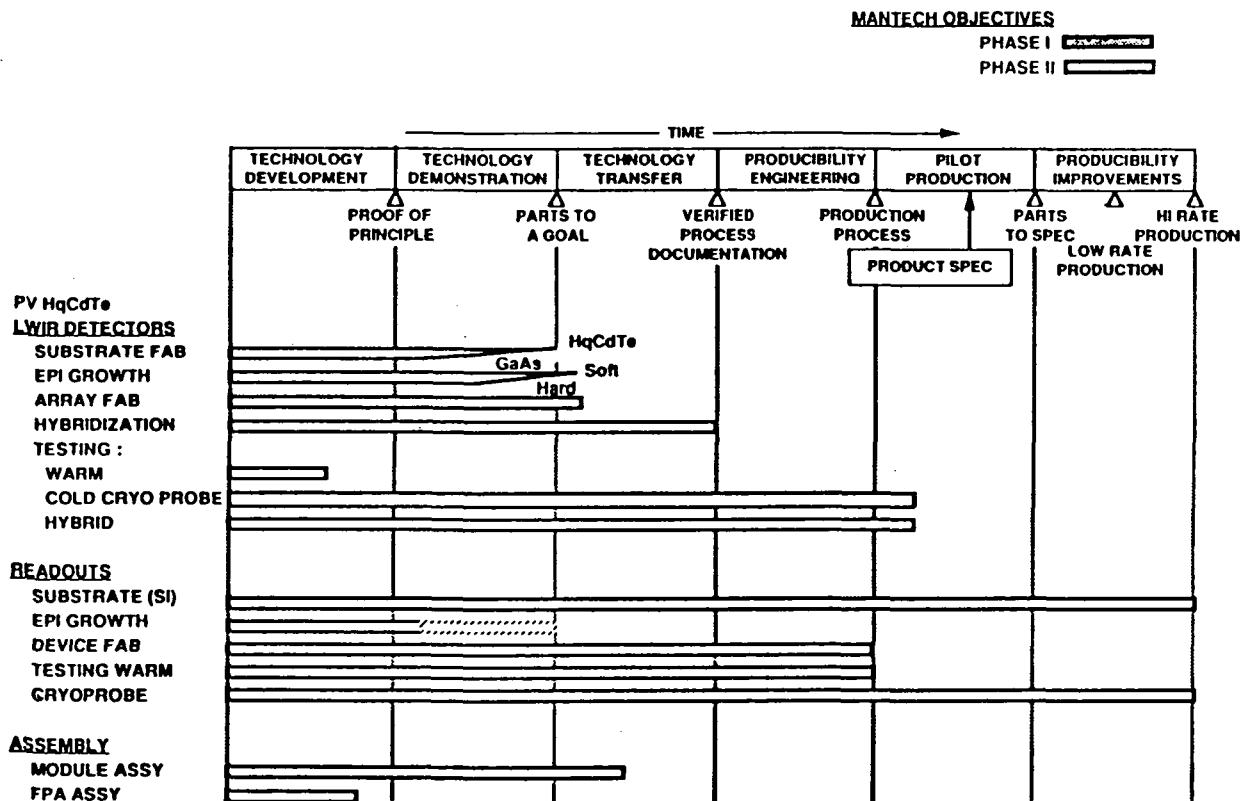
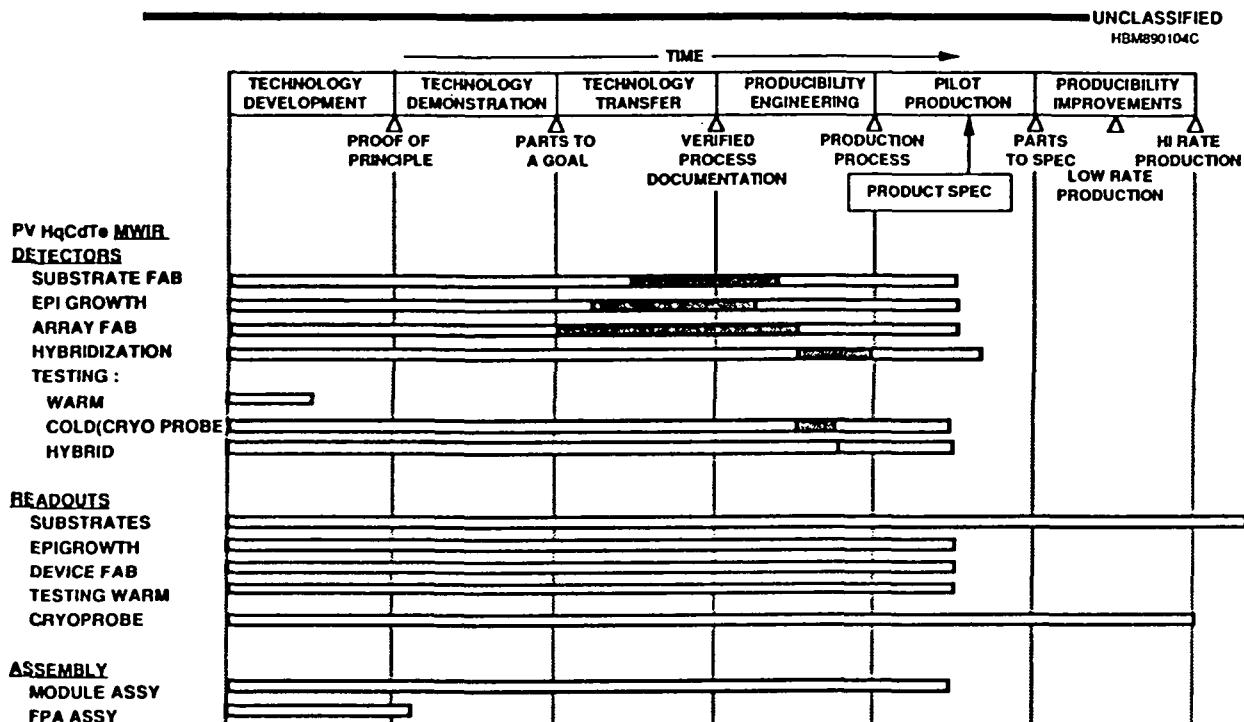


VLWIR TECHNOLOGY NEARS PILOT PRODUCTION (U)

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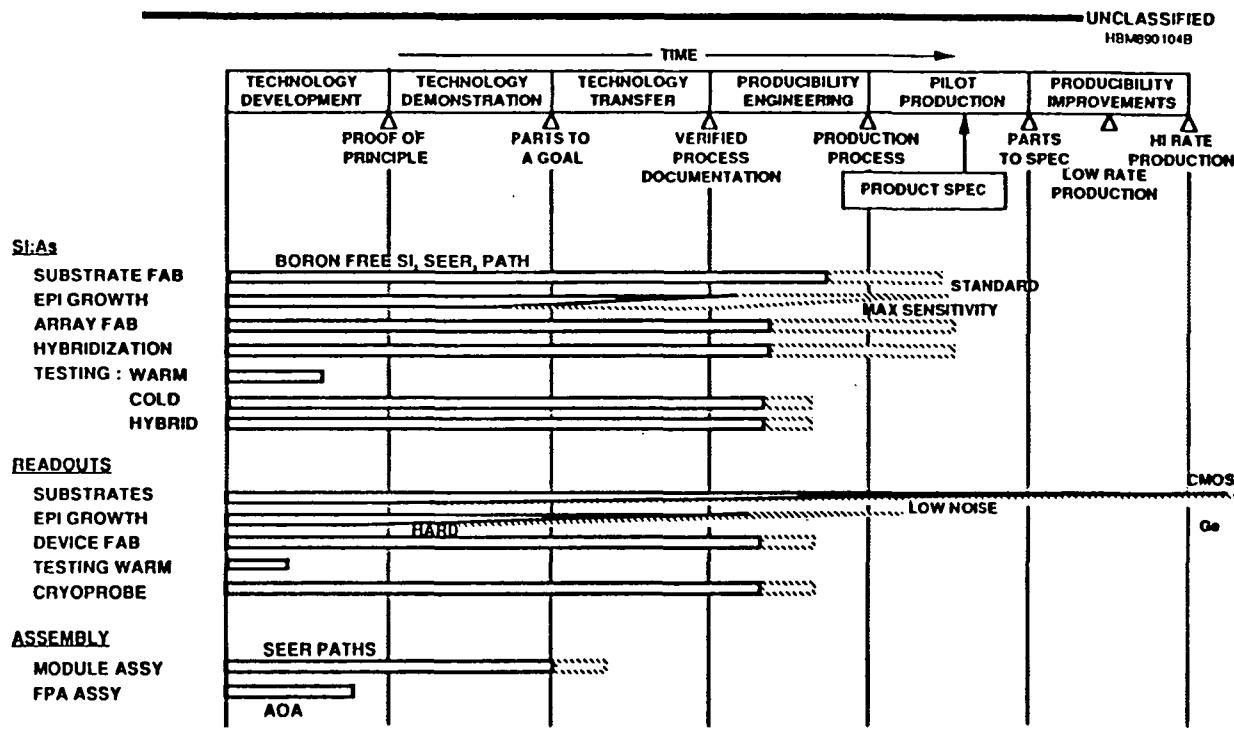


IR SENSOR COMPONENTS STATUS ON TECHNOLOGY CYCLE MODEL(U)



***** REMAINING SLIM EFFORT

IR SENSOR COMPONENTS STATUS ON TECHNOLOGY CYCLE MODEL(U)



~~~~~ REMAINING HYWAYS EFFORT



## FUTURE PLANS (U)

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### •NEAR TERM

HYWAYS - ADVANCED HYBRIDS FOR ENHANCED RADIATION TOLERANCE,  
HIGHER SENSITIVITY, LOWER NOISE  
HYWAYS - ENHANCED PRODUCTION RATES  
DECISION ON CONTINUATION OF SI:Ga

### •MID-TERM

IED PERFORMANCE IMPROVEMENTS  
EXTENDED WAVELENGTH RESPONSE  
MICROLENSES  
APPLICATION OF IBC TECHNOLOGY TO INTERCEPTOR REQUIREMENTS  
HIGHER OPERATING TEMPERATURE

### •FAR TERM

EXPLORE IBC CONCEPT IN OTHER MATERIALS AND DEVICES  
ADDRESS IED/SSPM PRODUCIBILITY

## **CONCLUSION**

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- TECHNOLOGY PROGRAMS ARE PLANNED TO ENCOMPASS SYSTEM NEEDS FOR DETECTOR/READOUT PERFORMANCE AND AVAILABILITY
- TECHNOLOGY PROGRAMS OR SYSTEM PROGRAMS MUST ADDRESS FPA INTEGRATION ISSUES
- HARDNESS IS THE LAGGING TECHNOLOGY
- HARDNESS IS SUFFICIENT FOR SPACE DEMO PROGRAM